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PLEISTOCENE MAMMALS FROM THE MA KAI VALLEY OF NORTHERN YUNNAN, CHINA¹

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INTRODUCTION

As part of the program of the Central Asiatic Expeditions of The American Museum of Natural History, Dr. Walter Granger, Palaeontologist of the Expeditions, made a short exploratory trip through the Chinese province of Yunnan during the winter of 1926-1927. This trip, more or less in the nature of a reconnaissance journey, precluded any attempts at collecting, yet it was possible for Dr. Granger to spend the better part of one day in the vicinity of Ma Kai, northern Yunnan, where in a valley there was found a rather extensive deposit containing Pleistocene fossils. This Pleistocene valley fill was in the nature of a very fine red clay, perhaps of aeolian origin, and it extended for considerable distances along the eastern side of the valley. In the short time spent at the place, Dr. Granger was able to collect a number of fossils,

principally teeth, and these form the subject of the present paper.

This contribution is the outgrowth of some studies originally undertaken upon a collection of Pleistocene fossils from Burma, which were discovered by Drs. P. Teilhard de Chardin and H. de Terra during their exploratory trip to southeastern Asia made in 1937 and 1938. In studying the Burmese fossils, it was found that certain comparisons might be evident between them and the hitherto undescribed specimens from Yunnan, so with a view to a better understanding of the faunas of the two regions, particularly with regard to the bearing that each might have upon the geological age of the other, this present study was made, with the kind consent of Dr. Granger. The illustrations were made by Mr. John C. Germann.

DESCRIPTION OF MATERIAL

The specimens described in the following pages came from the Ma Kai Valley in northern Yunnan, and south of the town of Ma Kai. Most of the material was found at a locality about ten miles south of that town, along the eastern side of the valley. The age is Pleistocene.

The probable affinities of this fauna, as compared with similar Pleistocene assemblages, and its probable position within the Pleistocene are discussed in succeeding pages of this paper.

Stegodon sp.

SPECIMEN UNDER CONSIDERATION.—

Amer. Mus. No. 38973, fragment of a ridge-plate.

A small fragment of a ridge-plate from a grinding tooth indicates the presence of *Stegodon* in the Ma Kai Valley deposits.

Rhinoceros sp.

SPECIMENS UNDER CONSIDERATION.—
Amer. Mus. No. 38971, several fragments from one or more upper cheek teeth.

A few fragments from an upper cheek tooth show that *Rhinoceros* was a constituent element of the Ma Kai fauna.

Equus yunnanensis, new species

TYPE.—Amer. Mus. No. 38960, nine associated upper cheek teeth, consisting of left

¹ Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 142.

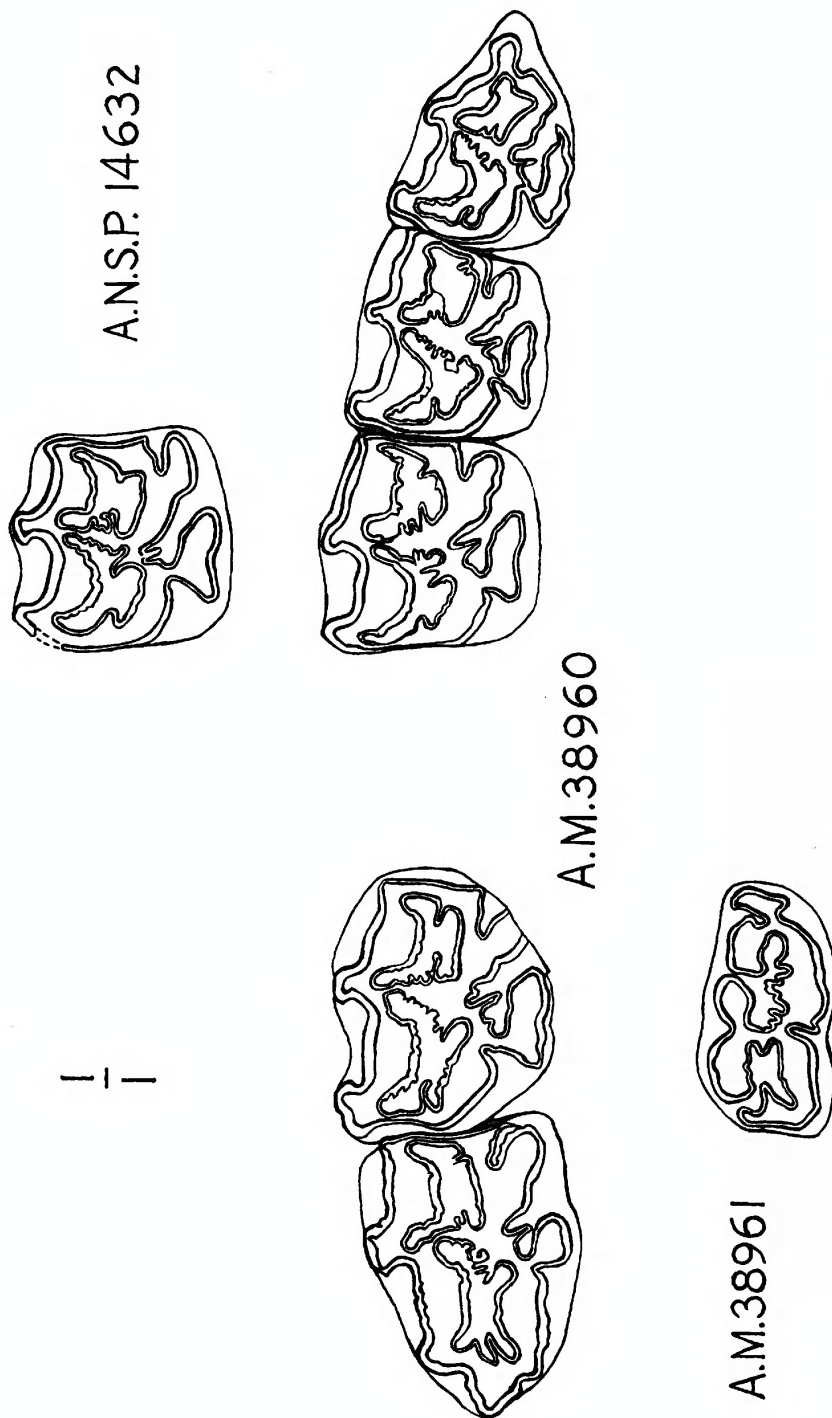


Fig. 1. *Equus yunnanensis*, new species. Amer. Mus. No. 38960, type; left P²⁻³, M¹⁻³. Amer. Mus. No. 38961, paratype; left P₃. Acad. Nat. Sci. Phila. No. 14632, referred specimen; left M¹. (From Burma.) Crown views, natural size.

P²⁻³, M¹⁻³, and right P³, M¹⁻² and a fragment of one other right tooth. Ten miles south of Ma Kai.

PARATYPES.—Amer. Mus. No. 38961, four lower cheek teeth, consisting of left P₂ and M₃, a broken left tooth, and a right M₂.

Amer. Mus. No. 38962, a series of about seventeen assorted upper and lower cheek teeth, not associated, and in various stages of wear. Also a lower first incisor and a "navicular" sesamoid. Ten miles south of Ma Kai.

Amer. Mus. No. 38963, left P₂, P₃, associated.

Amer. Mus. No. 38964, left P², right M².

The most numerous fossils from a single type of animal in the Ma Kai Valley deposits are the teeth of *Equus*. In all, there are about thirty teeth, premolars and molars, most of them single but a few associated.

These teeth represent a rather small horse, comparable—on the basis of this evidence alone—to the modern Przewalski horse or to some of the smaller zebras in size. They would seem to belong to an equid perhaps somewhat smaller than most of the Pleistocene horses hitherto described from the Asiatic-Oriental region; definitely smaller than *Equus sanmeniensis*, described by Teilhard and Piveteau from the lower Pleistocene of North China, and than the Indian species, *Equus sivalensis* and *Equus namadicus*.

These teeth from Yunnan are distinguished first by the moderately elongated protocone, secondly by the well-developed pli caballin, and thirdly by the strongly plicated enamel of the pre- and post-fossettes. The shape of the protocone at once eliminates the Yunnan horse from the *Equus stenonis* group in which the protocone is relatively round. In *Equus sanmeniensis* and *Equus namadicus* the protocone is noticeably more elongated than in the species under discussion; thus the closest comparison with regard to this single feature is to be found with *Equus sivalensis*. The Yunnan form also is distinguished from *Equus sanmeniensis* and *Equus namadicus* by its relatively stronger pli caballin. Incidentally, the presence of the well-developed pli caballin in this Yunnan form very probably eliminates it from relationship with the asses—in which the pli caballin is completely absent, or if

present, very small.¹ On the other hand, the Ma Kai *Equus* resembles *Equus sivalensis* in the complexity of the enamel folding on the fossettes, a character whereby it differs from *Equus sanmeniensis*, in which the fossette borders are relatively simple. In this character, the Ma Kai horse resembles also *Equus namadicus*.

The closest comparison to the Ma Kai horse, however, is to be found in a new, and as yet undescribed equid from the Pleistocene Upper Irrawaddy beds of Burma. This Burmese horse was discovered recently by the American Southeast Asiatic Expedition, in the course of studies being made upon the Pleistocene sedimentation of Burma by Drs. P. Teilhard de Chardin and H. de Terra. It is represented by two teeth, both of which are upper molars. One of these teeth, now in the collections of the Academy of Natural Sciences of Philadelphia, is very close to some of the molars from Ma Kai, particularly M¹ and M² numbered 38960. It is strikingly similar to these Ma Kai teeth in size, in the shape and size of the protocone, and in the configuration of the enamel pattern. Indeed, there can be but little doubt that all of these teeth are conspecific, thereby establishing a single form that ranged through upper Burma eastwardly into Yunnan in early Pleistocene times. The great similarities between these specimens of *Equus* from Burma and Yunnan are shown by the accompanying measurements, graphs and figure.

Of the modern equids, the form under discussion would seem to be about as near to *Equus przewalskii* as any. It is of similar size, has a similarly shaped protocone (although perhaps not quite so elongated anteriorly as in the recent species) and similarly shaped fossettes, though with perhaps somewhat more complexly folded enamel.

Taking all of the foregoing comparisons into account, it would seem probable that *Equus yunnanensis* is a distinct type of small size, identical to the Pleistocene

¹ Mr. S. H. Chubb, whose studies of the modern Equidae extend over many years, tells me that in the asses the pli caballin is absent, except in the kiang—where it is very small. In the horses and zebras it is present.

Equus from the upper Irrawaddies of Burma, similar to the Pleistocene *Equus* of India in certain features, and perhaps somewhat more advanced than the lower Pleistocene horse of Nihowan. Moreover, the Ma Kai *Equus*, by reason of its similarities to *Equus przewalskii* is quite possibly related to this modern species—perhaps both are offshoots from a common ancestral stock.

Cervus, sp. (A)

SPECIMENS UNDER CONSIDERATION.—
Amer. Mus. No. 38965, fragment of left mandibular ramus with M_{1-3} ; also broken P_{3-4} , evidently from the same ramus.

Amer. Mus. No. 38966, left P^4 . Also a right and a left astragalus. Not associated.

Amer. Mus. No. 38967, three antler bases. Miscellaneous antler fragments.

MEASUREMENTS (in mm.)

	<i>Equus przewalskii</i>	<i>Equus yunnanensis</i>			
		Yunnan	Yunnan	Yunnan	Burma
	A.M.CA136	A.M. 38960	A.M. 38962	A.M. 38964	1. A.N.S. 14632
		type	paratype	paratype	2. M.C.Z. 6258
	L × W	L × W	L × W	L × W	referred
P ²	38.3 × 27.0	36.5 × 27.0	<div style="border-left: 1px solid black; border-right: 1px solid black; padding: 5px; display: inline-block;"> 25.5 × 30.0 26.5 × 28.5 30.0 × 22.5 25.0 × 26.0 </div>	40. × 29.	L × W
P ³	29.0 × 28.5	32.0 × 27.0			
P ⁴	27.5 × 28.5	26.0 × 27.5 from opp. side			
M ¹	25.0 × 27.0	26.0 × 27.5			
M ²	25.0 × 25.5	25.5 × 26.5			27.5 × 26.5
M ³	31.0 × 24.0	28.0 × 24.0	28.0e × 24.5		

¹ A.N.S.—Academy of Natural Sciences of Philadelphia.

² M.C.Z.—Museum of Comparative Zoology of Harvard University.

MEASUREMENTS (in mm.)

	<i>Equus przewalskii</i>	<i>Equus yunnanensis</i>		
		A.M. 38961 paratype	A.M. 38962 paratype	A.M. 38963 paratype
	A.M.CA136			
	L × W	L × W	L × W	L × W
P_2	33.5 × 17.5		31.5 × 16.5	35.5 × 15.0
P_3	29.0 × 18.5	30.5 × 18.0	29.0 × 21.0	31.0 × 16.0
P_4	28.0 × 19.0	27.5 × 16.5	28.0 × 16.0	
			<div style="border-left: 1px solid black; border-right: 1px solid black; padding: 5px; display: inline-block;"> Not assoc., pos. not certain </div>	
M_1	26.0 × 18.0			
M_2	25.0 × 16.5	26.5 × 16.0		
M_3	36.0 × 15.5	33.0 × 15.5		

Sus, sp.

SPECIMEN UNDER CONSIDERATION.—
Amer. Mus. No. 38972, fragment of right maxilla with remnants of P^{3-4} , M^1 .

A very fragmentary specimen, containing remnants of the right P^{3-4} and M^1 . Nothing can be said about this specimen beyond the fact that it is referable to the genus *Sus*.

A large deer is represented in the Ma Kai fauna by a fragmentary left mandibular ramus and perhaps by some antler pieces. This deer is very probably one of the *Rusa* group, not unlike the modern *Cervus* (*Rusa*) *unicolor*. Definite similarities are to be seen in the lower teeth between this fossil and other specimens of *Rusa*, fossil and recent. They are characterized, in short,

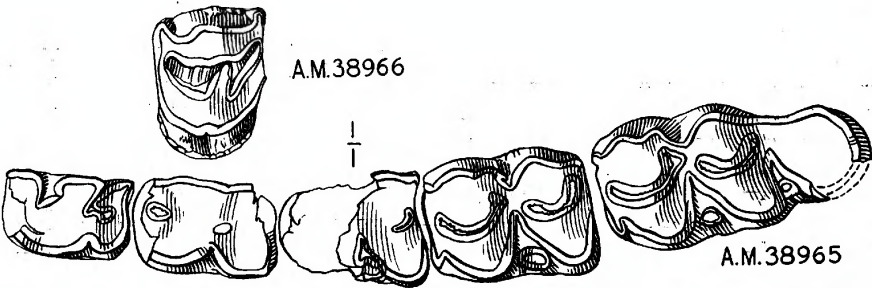


Fig. 2. *Cervus* sp. (A) Amer. Mus. No. 38965, left P₃-M₃. Amer. Mus. No. 38966, left P⁴. Crown view, natural size.

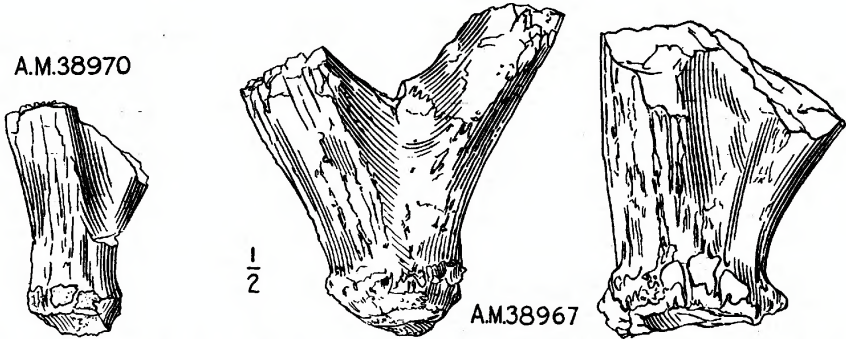


Fig. 3. *Cervus* sp. (A) Amer. Mus. No. 38967, two antler fragments. (B) Amer. Mus. No. 38970, antler fragment. Lateral views, one-half natural size.

MEASUREMENTS (in mm.)				
	<i>Cervus</i> sp. (A)		<i>Cervus</i> sp. (B)	
	A.M. 38966		A.M. 38968	A.M. 38969
	L × W		L × W	L × W
P ²				
P ³				
P ⁴	14.5 × 19.0			
M ¹				
M ²			18.0 × 19.0	18.0 × 19.0
M ³				
	A.M. 38965			
P ₂				
P ₃	18.0e × 11.0			
P ₄	20.0e × 12.0			
M ₁	21.0e × 14.5			
M ₂	22.0 × 16.5			17.0 × 11.0
M ₃	34.5 × 17.5		26.5 × 13.0	
			25.0 × 11.5	
			25.0e × 11.5	
			27.0e × 13.0	
	A.M. 38967		A.M. 38970	
Dia. antler base	a. 39.0 × 30.0		a. 23.0 × 18.5	
	b. 32.5 × 25.5		b. 27.0 × 20.0	
	c. 32.0 × 30.5		c. 22.0 × 17.5	

by their large size and heavy build, by the strongly rugose enamel, and by the strong external pillars—which are commonly found in *Rusa*. The fourth upper premolar is quite similar to the same tooth in *Rusa*. It is hypsodont and rugose, with a strong projection running into the fossette from the inner crescent. The antler fragments referred to the same type as these teeth are placed here mainly because of their large size; they resemble the antlers in the sambar by reason of the acute angle and the sharp bridge between the brow tine and the beam.

Cervus, sp. (B)

SPECIMENS UNDER CONSIDERATION.—Amer. Mus. No. 38968, a right upper molar, two right and two left lower third molars, fragment of another lower molar, right astragalus. Not associated.

Amer. Mus. No. 38969, left upper molar, right and left lower molars, associated.

Amer. Mus. No. 38970, three antler bases. Miscellaneous antler fragments.

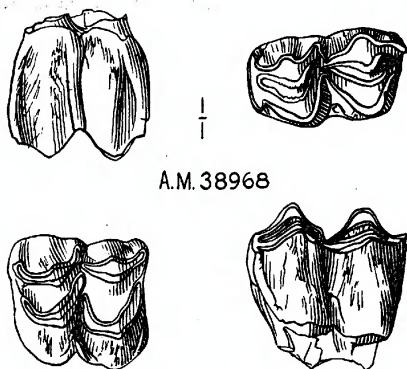


Fig. 4. *Cervus* sp. (B) Amer. Mus. No. 38968, right upper molar and left M_3 (heel missing). Crown and external lateral views, natural size.

In addition to the large deer from the valley deposits of Ma Kai, there is a smaller cervid, about three-fourths as large linearly as the foregoing type, described above. In this deer, the teeth are relatively hypsodont, and have strongly rugose enamel. There are strong styles on the

ectoloph of the upper molars, and well-developed internal pillars, while the crescents or selenids may be simple or may be complicated to a certain extent by small enamel points projecting into the fossettes. In the lower molars there may be small external pillars, or such structures may be entirely absent. Certain antler fragments of small size are hereby assigned to this lesser deer from Yunnan.

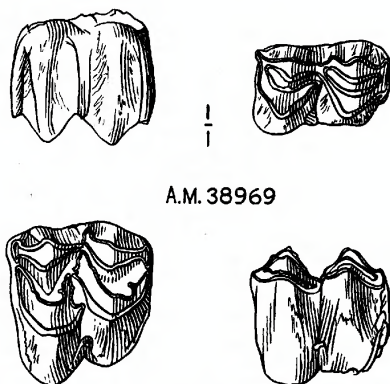


Fig. 5. *Cervus* sp. (B) Amer. Mus. No. 38969, left upper molar and right lower molar. Crown and external lateral views, natural size.

Bos (*Bibos*) (?) sp.

SPECIMENS UNDER CONSIDERATION.—Amer. Mus. No. 38974, a series of about twenty-three upper and lower cheek teeth. Also a left astragalus, two proximal phalanges, and a median phalanx.

A rather large bovine is represented in the Ma Kai fauna by a series of isolated upper and lower cheek teeth. These teeth in general are smaller than similar teeth of *Hemibos* from the Pleistocene Irrawaddies of Burma, and quite noticeably smaller than teeth of the modern *Bubalus* and gaur. They are characterized by the relatively simple fossette borders, of which in the posterior one there is always a simple re-entrant fold, in the posterior border. All in all, these teeth show rather close comparisons with the cheek teeth of the banting, *Bibos banting*, and it is quite possible that they represent a Pleistocene ancestor of this modern type.

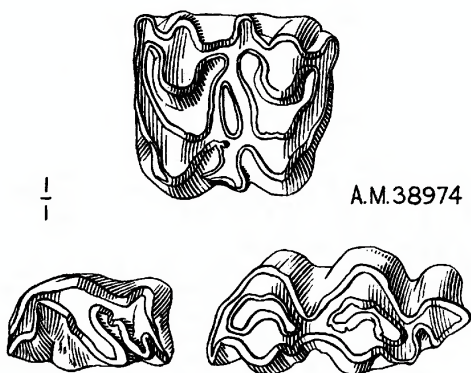


Fig. 6. *Bos (Bibos) (?)* sp. Amer. Mus. No. 38974, left upper molar, right P_4 and M_3 . Crown views, natural size.

Chelonian

The presence of turtles of fairly large size in the Ma Kai fauna is shown by sev-

MEASUREMENTS (in mm.)			
<i>Bos (Bibos) (?)</i> sp. A.M. 38974—various teeth			
	L × W		L × W
P^2	16.0 × 13.0	P_2	
P^3		P_3	21.5 × 11.5
P^4	15.5 × 17.5	P_4	
M^{1-3}	26.0 × 22.5	M_{1-2}	23.0 × 14.0
	24.0 × 20.5		25.0 × 16.5
	27.0 × 23.0	M_3	32.0 × 16.0
	26.0 × 23.5		
	26.0 × 24.0		
	27.5 × 23.0		
	28.0 × 21.0		

eral fragments of shell. These are too small to admit even of generic identification, yet they do indicate a terrestrial chelonian of the tortoise type, rather than a soft-shelled, or aquatic turtle.

THE PLEISTOCENE MAMMALIAN FAUNAS OF YUNNAN

Pleistocene fossils from Yunnan have been previously described by Young (1932), and by Bien and Chia (1938). Young described fossils from a cave known as Hoshangtung in the district of Fuminhsien, to the northwest of Kunming, a locality that was subsequently more extensively explored by Bien and Chia as a basis for their stratigraphic and faunal description of 1938. In addition, these latter authors described material from a rock shelter near the village of Heichinglungtsun, in the Chiupei district.

Incidentally, it might be mentioned that Young in his original paper on Yunnan, described a few fossils from a surface marl at a locality known as Tsaichiach'ung, in the district of Chutsingshsien, and ascribed an upper Tertiary age to these fossils and to the sediments in which they were found.

The fossils as described by these authors are listed below.

Tsaichiach'ung, Chutsingshsien (Young, 1932)

Carnivora, indet.
Rhinosauridae, indet.
Merycopotamus sp.

Cave deposits of Hoshangtung

(Young, 1932) (Bien and Chia, 1938)
Ursus, cf. *kokeni* *Ursus augustidens*
Aeluropus sp. *Aeluropus fovealis*
Hyaena, cf. *sinensis* *Ailurus fulgens*

Felis sp.
Hystrix sp.
Rhinoceros sp.
Tapirus sinensis
Sus sp.
Cervus sp. A
Cervus sp. B
Ovidae, indet. A
Ovidae, indet. B
Bovidae, indet.
Elephas sp.
? *Macacus* sp.
Arctonyx sp.
Hyaena ultima
Felis, cf. *tigris*
Felis, cf. *pardus*
Felis, cf. *lynx*
Hystrix sp.
Rhinoceros sp.
Megatapirus augustus
Sus sp.
Cervulus sp.
Rusa sp.
Ovidae, indet.
Bovidae, indet.
Stegodon sp.
Elephas namadicus
Macacus sp.
Simia, cf. *satyrus*

Rock Shelter of Heichinglungtsun, Chiupei (Bien and Chia, 1938)

Canidae, cf. *Canis lupus*
Ursidae, cf. *Ursus kokeni* or *Ursus augustidens*
Felidae, cf. *Felis pardus*
cf. *Felis catus*
Cervus sp.
Bovidae, indet.
Macacus sp.

From the foregoing account, it is to be seen that there are four fossil localities in Yunnan, at which the remains of extinct mammals have been found. These are:

- Tsaichiach'ung marls
- Ma Kai Valley silts
- Hoshangtung cave deposits
- Heichinglungtsun rock shelter

What are the geologic ages and the correlative equivalents of these deposits elsewhere?

a.—Tsaichiach'ung Marls

Of the three fragmentary fossils described from this horizon, only one, the tooth of *Merycopotamus* is definitive. Young, on the basis of this specimen, regarded the deposits in which it was contained to be essentially equivalent to the Dhok Pathan beds of India, in which the genus occurs.

"The anterior half, perfectly fresh, of a lower molar suggests the presence in Yunnan of this interesting form, highly characteristic of the middle Siwaliks of India (*Hipparion* beds)

"If our determination is correct, the date of the Chütsinghsien lake deposits would fall approximately in the Pontian. Similar formations of this age in Yunnan have already been determined by several geologists and specially by Dr. V. K. Ting (personal communication), on the basis of various tectonic, physiographic and palaeontological considerations."¹

It might be pointed out at this place that *Merycopotamus* is known from the Pleistocene Upper Siwalik beds of India, and from the Pleistocene Upper Irrawaddies of Burma, as well as from the Pliocene sediments of these regions. Therefore, on the basis of this genus alone, the Tsaichiach'ung marls cannot be proved to be of Upper Tertiary age, rather than of Pleistocene affinities. On the other hand, since Young states that similar beds in Yunnan have been determined as of Pliocene age on the basis of other lines of geologic evidence, there is no reason for doubting the inclusion of the Tsaichiach'ung sediments within the Pliocene. It is quite possible, however, that these Yunnan deposits are of middle Pliocene, or post-Pontian age, particularly if they are to be correlated with the Dhok Pathan formation of India and the Lower Irrawaddies of Burma.²

b.—Ma Kai Valley Silts

Looking at the Ma Kai fauna in retro-

spect, we see that it consists of the following forms.

Stegodon sp.
Rhinoceros sp.
Equus yunnanensis, new species
Sus sp.
Cervus sp. (A)
Cervus sp. (B)
Bos (*Bibos*) (?) sp.
 Chelonian

Of these genera, *Equus* is the most definitive by far, for the purposes of correlation. As has been shown above, the Ma Kai *Equus* would seem, upon the evidence of the teeth alone, to be almost identical with an *Equus* found in the Upper Irrawaddy sediments of Burma. Indeed, judging by the evidence at hand, these two representations of the genus, one in Burma and one in Yunnan appear to be conspecific. For this reason, and also because of the geographic contiguity of the two areas in question, there is strong evidence for believing that the Ma Kai silts are virtually correlative in age with the Upper Irrawaddy beds of Burma—at least with that section of the Upper Irrawaddies bearing the typically Upper Irrawaddian mammalian fauna. Consequently, on the basis of this reasoning, the Ma Kai deposits may for the present be regarded as of Lower Pleistocene age.

Similarly, the Ma Kai deposits may be compared with the Nihowan deposits of North China, containing a Lower Pleistocene mammalian assemblage, with comparable elements.

c.—Hoshangtung Cave Deposits

As Bien and Chia have already shown, the Hoshangtung fauna may be correlated with other similar cave and fissure faunas in China and other parts of Asia.

"Considered as a whole, the Hoshangtung fauna undoubtedly belongs to what is known as the *Ailuropus-Stegodon* fauna. This fauna is widely distributed in southeastern Asia in regions such as Burma, Indo-China, Yunnan, Kwangsi, Szechuan, etc. Its geological age, as repeatedly stated in previous papers, is early Pleistocene and corresponds to the *Sinanthropus* fauna of North China, but with the difference of its

¹ Young, C. C. 1932. Bull. Geol. Soc. China, XI, No. 4, pp. 383-393.

² See Colbert, E. H. 1938. Bull. Amer. Mus. Nat. Hist., LXXIV, Art. 6, pp. 276-277.

		India	Burma	Yunnan	Kwangsi	Szechwan	N. China
PLEISTOCENE	Upper	Potwar	Terrace deposits	Heichinglungtsun rock-shelter	Kweilin		Loess upper cave deposits
	Middle	Narbadda Boulder conglomerate	Mogok caves	Hoshangtung cave	Kwangsi caves, "yellow deposits"	Yenchingkou pits	Choukoutien
	Lower	Pinjor Tatrot	Upper Irrawaddy	Ma Kai Valley deposits			Nihowan (Sanmen)
PLIOCENE	Upper						Yüshe
	Middle	Dhok Pathan	Lower Irrawaddy	Tsaichiach'ung marls			

being composed mostly of southern elements."¹

It should be stated here that whether the Hoshangtung fauna is of "early" Pleistocene age or not, it very probably does not represent the earliest phases of the Pleistocene in Yunnan. The Chinese and Burmese cave faunas would seem to be indicative of a second stage in the Pleistocene history of southeastern Asia, a stage following the accumulation of basal Pleistocene, or Villafranchian, valley and basin sediments, in which the numerous elements of the typical Pleistocene mammalian assemblages of the Palaearctic region first appear. Indeed, there is a tendency among certain authorities to regard the cave and fissure deposits of this area as of Middle Pleistocene age—a view particularly supported recently by P. Teilhard de Chardin.

"Dr. P. Teilhard de Chardin . . . has diagnosed the fissure fauna [of Burma] as Middle Pleistocene, the same age as the *Stegodon-Orang* fauna of South China . . . the latter presumably represents the Choukoutien stage. . ."²

Certainly the Hoshangtung fauna is virtually identical with the fissure faunas of Mogok in Burma, and of Yenchingkou in Szechwan. And probably, although not quite so fully, with the Choukoutien fauna of North China. It is convenient at the

present time to regard these fissure faunas as of Middle Pleistocene age, succeeding the Upper Irrawaddy fauna in Burma, the Ma Kai fauna in Yunnan, and the Nihowan fauna in North China.

d.—Heichinglungtsun Rock Shelter

The fauna from this locality has been regarded by Bien and Chia as perhaps later in age than the Hoshangtung fauna. On the basis of the present evidence, this opinion would seem to be valid.

"Since no characteristic fossil is known from this locality, it is not possible yet to give a precise statement on the geological age of the present rock-shelter. The degree of mineralization of the fossils, though some of them are only slightly effected, may indicate that they are not of Holocene time. By comparing the state of preservation of bones from various fossil localities of South China, the present specimens come rather close to those known from Kweilin, Kwangsi, but some pieces of bone from the Heichinglungtsun rock-shelter seem to be even more strongly mineralized. If they are not of two different ages, we suggest them to be of an older age. Anyway, the present rock-shelter is not younger than the Kweilin Cave to which W. C. Pei has attributed tentatively a Mesolithic age."³

The relationships of the various mammalian horizons of Yunnan with each other and with similar horizons in adjacent regions are indicated by the above chart.

¹ Bien, M. N., and Chia, L. P. 1938. Bull. Geol. Soc. China, XVIII, Nos. 3-4, pp. 343-344.

² de Terra, H. 1938. News letter, entitled, "Second Scientific Report of the American Southeast Asiatic Expedition for Cenozoic Geology and Early Man." Issued by the Peabody Museum of Harvard University. Also personal conversations with the author.

³ Bien, M. N., and Chia, L. P. 1938, *op. cit.*, pp. 346-347.

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